

The origin of this work was based on the need to control an electric positioning bed by patients with no or significantly reduced upper limb motor skills. The key point and objective of the dissertation study was to develop non-contact alternatives to manual controls and to verify that the eye-tracking technique is usable and offers patients a new level of increased self-sufficiency. The thesis is organized into three related parts with experiments conducted at the detached departments and in the laboratory.

After an introductory section covering the stages of development and current progressive trends in eye movement tracking, an experimental study of the applicability of bed control with the role of alternating head and leg position changes using on-screen graphical controls is described. This stage was conducted using a virtual bed. In a group of 17 patients with diagnoses of a pentaplegia, tetraplegia, high paraplegia, myopathy, and spinal muscular atrophy, the overall time to solve the task was 67.1 s (median) with a large interindividual variability with interquartile range from 56.7 s to 92.9 s. The solution efficiency (100 % matched to optimal performance) was 45.5 (34.9; 62.0) %. Within each group patients achieved different results for both studied parameters. When evaluating the features of the system by questionnaire survey, the positive responses of 66/85 were prevailing, especially the contactless mode of operation and the ease of use were positively evaluated.

In the following section dealing with the implementation of the connection of the eye-tracking system to the positioning bed, the development of an innovative digital-to-analogue conversion module and a unique graphical user interface are described. Throughout the conceptualization process, the system underwent considerable development and was fully realizable using several commercially available electrical and mechanical components and a 3D printing method. The servicing application included a holding level (alternating diode glow), a selectable level (position of the head, feet and both simultaneously) and a confirmatory level (command input) with predefined control times.

The third part of the dissertation describes an experimental study of the ergonomics and the usability of the prototype. The testing was carried out similarly to the feasibility study, but with real leg and head positioning. The experiment involved 26 volunteers in the control group and 17 multiple sclerosis patients. Patients' health status ranged from 7 to 9.5 points (10 corresponds to death) according to a scale quantifying nervous system impairment. The control group completed the task in 40.2 s (34.5; 45.5) s and the patients completed the task in 56.5 s (46.5; 64.9) s. The task solving efficiency was 86.3 (81.6; 91.0) % for the control group and 72.1 (63.0; 75.2) % for the patient group. Patients' efficiency and time to solve

improved with repeated test administration. Correlation analysis showed that a higher degree of medical limitation was significantly related ( $\rho = -0.587$ ) to slower efficiency gains. In the control group, the repetition effect was not significant. In the questionnaire survey, sixteen patients reported that they had gained confidence in operating. Seven patients preferred the offered form of bed control to other technologies familiar to them.